AD NUMBER
AD825643
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; 15 FEB 1968. Other requests shall be referred to Air Force Applications Technical Center, Washington, DC 20330.**
AUTHORITY
AFTAC/USAF ltr 28 Feb 1972

SDL DATA SERVICES REPORT

15 January 1968

Prepared For

AIR FORCE TECHNICAL APPLICATIONS CENTER
Washington, D. C.

By

TELEDYNE INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY
Nuclear Test Detection Office
ARPA Order No. 624

SDL DATA SERVICES REPORT

15 January 1968

AFTAC Project No.:	VELA T/6702
Project Title:	Seismic Data Laboratory
ARPA Order No.:	624
ARPA Program Code No.:	5810
Name of Contractor:	TELEDYNE INC.
Contract No.:	F 33657-67-C-1313
Date of Contract:	2 March 1967
Amount of Contract:	$ 1,736,617
Contract Expiration Date:	1 March 1968
Project Manager:	William C. Dean (703) 836-7644

P. O. Box 334, Alexandria, Virginia

AVAILABILITY

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of Chief, AFTAC. Washington, DC

This research was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, under Project VELA-UNIFORM and accomplished under the technical direction of the Air Force Technical Applications Center under Contract F 33657-67-C-1313.

Neither the Advanced Research Projects Agency nor the Air Force Technical Applications Center will be responsible for information contained herein which may have been supplied by other organizations or contractors, and this document is subject to later revision as may be necessary.

SDL DATA SERVICES

INTRODUCTION

This report lists the data services, computer programs and other data available from the Seismic Data Laboratory (SDL). The following items are described in this report:

I. Digital computer programs (abstracts).

II. Digitized seismic data.

III. U.S. Coast and Geodetic Survey epicenters on punched cards.

IV. Earthquake bulletin data (LRSM and VELA observatories),

V. Shot Report data on punched cards from 82 U.S. nuclear explosions.

Space is available for persons who wish to study data at the SDL. Those who wish to visit the SDL, or request data, should direct their inquiries to:

Headquarters, USAF/AFTAC
VELA Seismological Center
Washington, D.C. 20333

Att: Project Officer, Seismic Data Lab

I. DIGITAL COMPUTER PROGRAM ABSTRACTS

ALL PROGRAMS IN THIS LIST HAVE BEEN WRITTEN IN FORTRAN. COPIES OF THE SOURCE DECK, PROGRAM LISTINGS, AND PROGRAM WRITE-UPS ARE AVAILABLE ON REQUEST.

A. CORRELATION AND REGRESSION ANALYSIS

1. AUTCOV — AUTOCOVARIANCE SUBROUTINE

   FORTRAN. COMPUTES THE AUTOCOVARIANCE OF A SERIES OF N TERMS WITH L LAGS.

2. AUTOCOR — AUTO-CORRELATION ANALYSIS

   FORTRAN. GIVEN A SERIES OF VALUES $X(1)$, $X(2)$,...$X(N)$, THIS PROGRAM WILL COMPUTE THE PRODUCT-MOMENT CORRELATION COEFFICIENT (AUTO-CORRELATION) BETWEEN SUCCESSIVE TERMS, WHERE THE LAG(K) GOES FROM 0,1,...,L.

3. CRSCOV — AUTO- AND CROSS-VARIANCE SUBROUTINE

   FORTRAN. GIVEN TWO SERIES X AND Y EACH OF N POINTS, COMPUTES AUTOCOVARIANCE OF X AND Y AND CROSS-VARIANCE OF X TO Y AND Y TO X.

4. FRENORM — FREQUENCY AND TEST OF NORMALITY

   FORTRAN. GIVEN DIGITIZED SEISMIC NOISE DATA, THIS ROUTINE INVESTIGATES THE DISTRIBUTION OF SEISMIC NOISE AMPLITUDES.

5. LOGNORM — MEAN AND SAMPLE VARIANCE OF POWER SPECTRA ESTIMATES

   FORTRAN. TO COMPUTE THE SAMPLE MEAN, VARIANCE, AND CONFIDENCE LIMITS OF POWER SPECTRAL ESTIMATES, UNDER ASSUMPTIONS THAT LOG OF THE POWER IS NORMALLY DISTRIBUTED.

6. MANYCOR — CORRELATION ANALYSIS

   FORTRAN. GIVEN M SETS OF DATA, THIS PROGRAM CALCULATES THE MEAN, CORRECTED SUM OF SQUARES, VARIANCE, AND STANDARD DEVIATION FOR EACH SET. ALSO COMPUTES THE REGRESSION COEFFICIENTS, (LINEAR) CORRELATION COEFFICIENTS, AND THE STANDARD ERROR OF ESTIMATE FOR ALL POSSIBLE COMBINATIONS OF SETS OF DATA.

7. PULSCOR — STATISTICAL ANALYSIS

   FORTRAN. TO CORRELATE A GIVEN PULSE OF A SEISMOGRAM WITH CORRESPONDING TIME INTERVALS THROUGHOUT THE SEISMOGRAM USING THE DENOYER METHOD.

8. RECCOR — RECURSIVE CORRELATION

   FORTRAN. TO COMPUTE THE MINIMUM VARIANCE ESTIMATE OF THE JOINTLY CORRELATED SIGNAL FROM MULTI-CHANNEL RECORDS.

B. TIME SERIES ANALYSIS

1. BLACKY4 CROSS SPECTRA, AND POWER SPECTRA

FORTRAN. THIS PROGRAM IS A REVISED AND SUPPLEMENTED VERSION OF THE PROGRAM TUKEY FROM UCSD. CAPABILITIES INCLUDE FILTERING, DECIMATING, REMOVING TREND OF DEGREE, PLOTTING OF SEMILOG AND/OR LINEAR PLOTS OF POWER AND/OR AUTOCORRELATION SPECTRA, AND SPECIAL SMOOTHING FEATURE.

2. COHERNCY TIME SERIES ANALYSIS

FORTRAN. TO COMPUTE ALL THE ORDINARY COHERNCIES, AUTO-SPECTRA, AND PHASE RELATIONS OF A SET OF INPUT DATA CHANNELS.

3. COLYTUKY SPECTRAL ANALYSIS

FORTRAN. THIS PROGRAM COMPUTES AUTO-SPECTRA, CROSS-SPECTRA, AUTO-CORRELATIONS, CROSS-CORRELATIONS AND COHERENCIES USING THE COULY-TUKEY METHOD. FOURIER TRANSFORMS OF THE DATA ARE FIRST COMPUTED AND THEN MANIPULATED TO GIVE THE DESIRED RESULTS. THIS PROGRAM IS INTENDED AS AN ALTERNATIVE TO PROGRAM BLACKY.

4. COOL HYPER-RAPID SPECIALIZED COOLEY-TUKEY FOURIER TRANSFORM

FORTRAN. TO COMPUTE THE FOURIER SERIES EXPANSION OF A REAL- OR COMPLEX- VALUED DATA SERIES, OR THE DATA SERIES FROM THE COMPLEX-VALUED FOURIER SERIES EXPANSION.

5. COOLER HYPER-RAPID SPECIALIZED COOLEY-TUKEY FOURIER TRANSFORM

FORTRAN. TO COMPUTE THE FOURIER SERIES EXPANSION OF A REAL VALUED TIME SERIES.

6. COOLTWO FOURIER TRANSFORM OF TWO DATA SERIES SIMULTANEOUSLY

FORTRAN. TO COMPUTE THE FOURIER SERIES EXPANSION, USING COOL (Q.V.) OF TWO DATA SERIES SIMULTANEOUSLY.

7. FASTFTI FAST DIRECT AND INVERSE FOURIER TRANSFORM

FORTRAN. COMPUTES THE DIRECT AND INVERSE FOURIER TRANSFORM OF A PERIODIC FUNCTION.

8. FKSPTRUM TIME SERIES ANALYSIS

FORTRAN. TO COMPUTE AND DISPLAY THE FREQUENCY-WAVE NUMBER POWER SPECTRA OF SEISMIC NOISE ALONG WITH A RESPONSE FUNCTION FOR THE CORRESPONDING ARRAY. THIS PROGRAM IS INTENDED AS A REPLACEMENT FOR CERTAIN PARTS OF PROGRAM PEAKAY USING THE COOLEY-TUKEY METHOD TO ESTIMATE AUTO AND CROSS POWER SPECTRAL DENSITY FUNCTIONS.

9. FOULAGR1 FOURIER-LAGUERRE TRANSFORM

FORTRAN. EXPANDS A GIVEN TIME FUNCTION IN A SERIES OF LAGUERRE FUNCTIONS, AND FROM THE LAGUERRE EXPANSION COMPUTES FOURIER AMPLITUDE, PHASE, AND POWER SPECTRA.

10. FOULAGR2 DIRECT FOURIER-LAGUERRE TRANSFORM

FORTRAN. GIVEN A TIME SERIES, THIS PROGRAM COMPUTES AND PLOTS ON A SEMI-LOG OR LOG-LOG BASIS, THE AMPLITUDE, POWER, AND PHASE SPECTRA. THE PROGRAM PRINTS THESE QUANTITIES ALONG WITH THEIR LAGUERRE FUNCTION EXPANSION, AND COMPUTES THE WEIGHTING FUNCTION IN POSITIVE OR NEGATIVE TIME MEASURED AT THE LAGUERRE SAMPLE POINTS OF THE GIVEN TIME SERIES.

11. FOURAN FOURIER ANALYSIS SUBROUTINE

FORTRAN. GIVEN A TIME SERIES OF N POINTS, COMPUTES SINE TRANSFORM, COSINE TRANSFORM, MODULUS A, MODULUS NORMED, LOG A, PHASE (FRACTION OF A CIRCLE), AND MAXIMUM VALUE OF THE MODULUS.

12. FOURTR FOURIER ANALYSIS SUBROUTINE

FORTRAN. COMPUTES THE SINE OR COSINE, SMOOTHED OR UNSMOOTHED TRANSFORM OF A SERIES OF M TERMS.

13. FOUTRSAT FOURIER TRANSFORM

FORTRAN. GIVEN A TIME SERIES OF N POINTS, THE PROGRAM COMPUTES AMPLITUDE, PHASE, FREQUENCY, AND A POWER SPECTRUM WITH THE USE OF FOURIER TRANSFORMS.

14. FRAMIS COMPUTATION OF SPECTRA AND PHASE FROM THE LAPLACE TRANSFORM

FORTRAN. GIVEN THE PARAMETERS IN THE LAPLACE TRANSFORM, THIS PROGRAM EVALUATES THE AMPLITUDE SPECTRA AND PHASE OF THE TRANSFORMATION.

15. FTP HYPER-RAPID FOURIER TRANSFORM PACKAGE

FORTRAN. THIS IS A PACKAGE OF SIX SUBROUTINES FOR CALCULATING FOURIER TRANSFORMS AND MANIPULATING COMPLEX DATA. THEIR NAMES ARE- FTPACK66, DFTRND63, TAPER63, COOL, SCALE63, AND DRUM63. THE PACKAGE ALLOWS DETRENDING AND TAPERING ON DIRECT TRANSFORMS, AND TAPERING DATA ON INVERSE TRANSFORM. IN ADDITION THE PACKAGE WILL COMPUTE AN AMPLITUDE-PHASE OR POLAR REPRESENTATION OF THE FOURIER TRANSFORM ON DIRECT TRANSFORM AND WILL ACCEPT THE DATA IN DIFFERENT FORMS FOR INVERSE TRANSFORM.

16. FT2DCOOL, FT3DCOOL TWO AND THREE DIMENSIONAL FOURIER TRANSFORM PACKAGE

FORTRAN. THE SUBROUTINES IN THIS PACKAGE COMPUTE TWO AND THREE DIMENSIONAL FOURIER TRANSFORMS. THEIR NAMES ARE- FT2DCOOL,

FTSDCOOL, COOL, MATRAGS, AND SCALE. AS WITH COOL, THE DIMENSIONS ON THE DATA MUST BE A POWER OF TWO.

17. GRTZEL FOURIER TRANSFORM BY GOERTZEL S METHOD

FORTRAN. TO COMPUTE THE FOURIER SERIES EXPANSION OF A REAL-VALUED EVEN FUNCTION, OR THE REAL-VALUED EVEN FUNCTION OF A REAL-VALUED FOURIER SERIES EXPANSION.

18. MULTICOH TIME SERIES ANALYSIS

FORTRAN. THIS PROGRAM COMPUTES MULTIPLE COHERENCE FUNCTIONS FOR SEISMIC ARRAY DATA RAPIDLY AND EFFICIENTLY. GIVEN AN ORIGINAL SET OF N SUBSET DATA CHANNELS, THE PROGRAM WILL COMPUTE THE N-1 MULTIPLE COHERNCE FUNCTIONS- $X(I)(N-I/N,\ldots,N-I+_1)$, WHERE $I = 1\ldots N-_1$. THIS PROGRAM WILL THEN REORDER THE N DATA CHANNELS ANY NUMBER OF TIMES, EACH TIME COMPUTING ANOTHER $N-_1$ MULTIPLE COHERENCE FUNCTION. THE PRINT-OUT INCLUDES A DESCRIPTION OF THE NOTATION USED. OPTIONAL PRINT-OUT INCLUDES ALL THE AUTO AND CROSS SPECTRA. IN ADDITION A PROVISION EXISTS TO PLOT THE MULTIPLE COHERENCE FUNCTIONS. THE COOLEY-TUKEY METHOD OF SPECTRAL ESTIMATION IS USED TO OBTAIN HIGH SPEED.

19. PARTLCOH TIME SERIES ANALYSIS

FORTRAN. THIS PROGRAM COMPUTES PARTIAL COHERENCE FUNCTIONS FOR TAPED DATA. THE PROGRAM ALSO COMPUTES THE AMPLITUDE AND PHASE OF THE ASSOCIATED TRANSFER FUNCTION. THE OUTPUT INCLUDES PRINTOUTS OF THESE FUNCTIONS AS WELL AS PLOTS OF THE COHERENCE FUNCTIONS. THE COOLEY-TUKEY METHOD OF SPECTRAL ESTIMATION IS USED TO OBTAIN HIGH SPEED.

20. PREDICT TIME SERIES ANALYSIS

FORTRAN. TO COMPUTE A PREDICTION OF THE STRAIGHT SUM OF MULTI-CHANNEL ARRAYS, ISPAN UNITS AHEAD IN TIME WHERE ISPAN IS THE PREDICTION SPAN. THE PREDICTED SUM AND THE ACTUAL SUM ARE SUBTRACTED TO YIELD A PREDICTION ERROR, AND ALL ARE PLOTTED TO THE SAME SCALE FACTOR. ALSO, TO COMPUTE AND PLOT POWER-SPECTRA OF THESE TRACES.

21. PRER TIME SERIES ANALYSIS

FORTRAN. THIS PROGRAM DOES PREDICTION ERROR FILTERING OF SEISMOGRAMS.

22. PSD THEORETICAL POWER SPECTRAL DENSITY

FORTRAN. TO COMPUTE THE THEORETICAL POWER SPECTRAL DENSITY FOR GAUSSIAN MARKOV MODEL.

23. RLTMPWR REAL TIME POWER SPECTRA

FORTRAN. TO COMPUTE THE REAL TIME POWER SPECTRA FUNCTIONS FOR EITHER OVERLAPPING OR NON-OVERLAPPING TIME INTERVALS FOR A SPECIFIED DURATION.

24. TUKEY. TUKEY SPECTRUM, CROSS SPECTRA AND POWER SPECTRA

FORTRAN. THIS TIME SERIES ANALYSIS PROGRAM CONTAINS THREE BASIC SUBROUTINES. THE FIRST TWO, FILTER AND REMOVAL OF TREND, PREPARE THE DATA FOR THE SPECTRUM ANALYSIS SUBPROGRAM. TUKEY SPECTRUM COMPUTES FOR THE TWO SIMULTANEOUS TIME SERIES, THE CROSS (CO- AND QUADRATURE-) SPECTRA, AND THE TWO POWER SPECTRA. PHASE AND COHERENCE ARE CALCULATED.

25. VELQLAG LAGUERRE EXPANSION, FOURIER ANALYSIS

FORTRAN. COMPUTES THE LAGUERRE EXPANSION OF SURFACE WAVES RECORDED AT STATIONS ALONG A PROFILE. FROM THE LAGUERRE EXPANSION IT COMPUTES FOURIER SPECTRA, AND FROM THE FOURIER SPECTRA IT COMPUTES PHASE VELOCITY, ATTENUATION, AND Q AS FUNCTIONS OF FREQUENCY BETWEEN PAIRS OF STATIONS.

26. VFKSPTRM TIME SERIES ANALYSIS

FORTRAN. TO COMPUTE AND DISPLAY THE FREQUENCY-WAVE NUMBER POWER SPECTRA OF SEISMIC NOISE ALONG WITH A RESPONSE FUNCTION FOR THE CORRESPONDING VERTICAL ARRAY.

C. DIGITAL FILTERING

1. ANLGFLTR ANALOG FILTER SUBROUTINE

FORTRAN. THIS SUBROUTINE PERFORMS LOW PASS AND HIGH PASS FILTERING OF DIGITAL DATA IN THE SAME WAY THAT ANALOG FILTERS DO OF ANALOG DATA.

2. CALC PROGRAMMED ARITHEMITIC, REAL

FORTRAN. GIVEN THE CENTER FREQUENCY AND BANDWIDTH OF A BAND-PASS FILTER, THIS SUBROUTINE COMPUTES RECURSIVE DIGITAL FILTER COEFFICIENTS.

3. COEFFT FILTER COEFFICIENTS FOR BAND PASS FILTER

FORTRAN. GIVEN THE CENTER OF BAND PASS, HALF-WIDTH OF BAND, AND ROLL-OFF IN TERMS OF NORMALIZED FREQUENCY (FREQUENCY TIMES THE TIME INCREMENT), AND THE NUMBER OF COEFFICIENTS IN HALF OF A SYMMETRIC FILTER. COMPUTES AND RETURNS THE BAND PASS FILTER COEFFICIENTS.

4. DCONVOLI INVERSE CONVOLUTION FILTER

FORTRAN. TO REMOVE THE RESPONSE IN A SEISMOGRAM DUE TO THE INHERENT FILTER CHARACTERISTICS OF THE SEISMOMETER, FILTER, VELOCITY TRANSDUCER, AND GALVANOMETER. THE ROUTINE REMOVES THE RESPONSE OF ONE INSTRUMENT AT A TIME USING THE FILTER CHARACTERISTICS OF THAT INSTRUMENT. SUCESSIVE PASSES THROUGH THE ROUTINE WITH DIFFERENT FILTER CHARACTERISTICS WILL REMOVE ALL THE UNDESIRED RESPONSES.

5. FASTFIL FAST BROADBAND FILTER

FORTRAN. TO BROADBAND PASS FILTER SEISMOGRAMS.

6. FCON GENERATE FILTER COEFFIENTS

FORTRAN. THIS ROUTINE IS USED TO GENERATE COEFFICIENTS FOR THE DISCRETE LAGUERRE FILTER (POINTFLT) SUBROUTINE.

7. FILDEC DIGITAL FILTER AND DECIMATOR SUBROUTINE

FORTRAN. FILTERS AND DECIMATES A GIVEN SERIES OF N POINTS WITH GIVEN FILTER COEFFICIENTS AND RETURNS THE FILTERED AND DECIMATED SERIES.

8. FILNOIS DIGITAL FILTERING

FORTRAN. TO FILTER TIME SERIES WHICH ARE READ FROM A BINARY INPUT TAPE WITH A SET OF FILTER COEFFICIENTS AND WRITE THE FILTERED DATA ON AN OUTPUT BINARY TAPE. THE FILTER COEFFICIENTS MAY BE READ IN FROM CARDS OR THEY MAY BE SYMMETRICAL BAND-PASS COEFFICIENTS DESIGNED WITH THE USE OF SUBROUTINE COEFFT (UFS G102). THE PROGRAM HAS THE OPTIONS OF PRINTING THE FILTER COEFFICIENTS.

9. FILPLOT FREQUENCY RESPONSE OF DIGITAL FILTER

FORTRAN. 1. TO COMPUTE, PRINT, AND PLOT THE FREQUENCY RESPONSE OF A SYMMETRIC DIGITAL FILTER, AS SPECIFIED BY ITS COEFFICIENTS.

2. ALTERNATIVELY, TO COMPUTE THE FILTER COEFFICIENTS FROM THE DESIRED FILTER CHARACTERISTIC, GIVEN THE NUMBER OF COEFFICIENTS, AND THEN CARRY OUT (1).

10. FILTER FILTER SUBROUTINE

FORTRAN. APPLIES GIVEN FILTER COEFFICIENTS TO A SERIES OF N POINTS AND RETURNS THE FILTERED SERIES.

11. LANDM1 A RECURSIVE FILTER

FORTRAN. GIVEN THE COEFFICIENTS OF A NUMERICAL FILTER AND CONSECUTIVE SEGMENTS OF AN INPUT DATA SERIES, THIS ROUTINE GENERATES THE SEGMENTS OF THE CORRESPONDING FILTERED SERIES. THE ENTIRE SERIES IS FILTERED BY MEANS OF SUCCESSIVE CALLS TO THE SUBROUTINE.

12. LOPA7 LOW PASS AND HIGH PASS FILTERING BY DIGITAL APPROXIMATION TO ANALOG FILTERING

FORTRAN. THIS PROGRAM PERFORMS LOW PASS AND HIGH PASS FILTERING OF DATA ON A SUBSET FORMAT TAPE, AND PRODUCES ANOTHER SUBSET TAPE AND A PLOT TAPE OF THE FILTERED DATA.

13. MAIN INTERPOLATIONS AND APPROXIMATIONS, FILTERING

FORTRAN. THIS PROGRAM PRODUCES RECURSIVE DIGITAL FILTER COEFFICIENTS FOR LOW-PASS OR BAND-PASS FILTERS. AS SUCH MOST OF ITS OPERATION IS I/O AND BOOKKEEPING, WITH THE COMPUTATIONAL ASPECTS OF THE PROBLEM BEING RELEGATED TO SUBROUTINE.
IT SHOULD BE NOTED THAT THE PROGRAM WAS WRITTEN WITH LOW-PASS AND BAND-PASS INCORPORATED SUBROUTINES TO GENERATE DIGITAL FILTERS. HOWEVER, IT CAN BE USED TO MODEL A GENERAL FILTER PROVIDED THE COEFFICIENTS OF THE CONVENTIONAL PROTOTYPE FILTERS TRANSFER FUNCTION ARE GIVEN AND THE POLES OF THE PROTOTYPE ARE OF MULTIPLICITY ONE.

14. MAXLIK MAXIMUM LIKELIHOOD FILTER PROGRAM

FORTRAN. THIS PROGRAM COMPUTES AND/OR APPLIES A 21 OR 30 POINT MAXIMUM-LIKLIHOOD FILTER (REALIZABLE OR SYMMETRIC) TO SEISMIC ARRAY DATA. PRINTED OUTPUT IS PRODUCED AS WELL AS A PLOT TAPE DISPLAYING THE INPUT AND OUTPUT DATA AND USEFUL COMPUTED INFORMATION. IN ADDITION, A SAVE TAPE IS GENERATED WITH ALL PERTINENT DATA ABOUT THE OPERATION WRITTEN IN AN EASILY ACCESSIBLE FORM. A PROVISION EXISTS TO RUN THE PROGRAM FROM THE SAVE TAPE PROCESSING NEW DATA WITH BOTH KINDS OF MAXIMUM-LIKELIHOOD FILTERS. IN THIS CASE, EITHER FILTER IS EFFICIENTLY RE-COMPUTED FROM INFORMATION WRITTEN ON THE SAVE TAPE AND A NEW SAVE TAPE IS GENERATED WITH DETAILS OF THE NEW FILTER AND ITS OPERATION.
THE PRINTED OUTPUT INCLUDES THE ACTUAL SUMMATION CONSTRAINT SATISFIED BY THE FILTER COEFFICIENTS. THIS IS FOR REALIZABLE FILTERS AND FOR SYMMETRIC FILTERS.

15. MAX-LIKE MAXIMUM-LIKELIHOOD FILTER PACKAGE 66

FORTRAN. THIS IS A PACKAGE OF SUBROUTINES FOR COMPUTING A MAXIMUM-LIKELIHOOD FILTER FOR DIGITAL DATA, GIVEN THE CORRELATION MATRIX OF A NOISE SAMPLE AND A SUMMATION CONSTRAINT MATRIX. ONLY THE CALLING SEQUENCE FOR THE FIRST AND MASTER SUBROUTINE, LEVIN66 IS DESCRIBED, SINCE ALL THE OTHERS IN THE PACKAGE ARE CALLED INTERNALLY FROM IT OR FROM EACH OTHER. THEIR SUBROUTINE NAMES ARE- BLKMGU, MAINE, MAIMPY, MOVE, MAIDEN, AND SIMEQ7. THE RESULTING FILTER, WHEN APPLIED TO A GROUP OF INPUT CHANNELS OF DATA, WILL PRODUCE ONE OR MORE OUTPUTS SUCH THAT THE TOTAL OUTPUT POWER IS A MINIMUM SUBJECT TO THE CONSTRAINT SUPPLIED. THIS FILTER IS SOMETIMES REFERRED TO AS A MINIMUM VARIANCE UNBIASED FILTER. LEVINSON RECURSION IS USED TO COMPUTE THE FILTER. THIS PROCEDURE TAKES ADVANTAGE OF THE SYMMETRY OF THE MATRICES IN ORDER TO INCREASE THE MAXIMUM NUMBER OF INPUT CHANNELS AND THE ALLOWABLE FILTER LENGTH WHILE DECREASING THE REQUIRED COMPUTING TIME.

16. PHILTER LINEAR MULTICHANNEL CONVOLUTION FILTER FOR TAPED DATA

FORTRAN. AN INPUT TAPE OF UNMULTIPLEXED DATA IN THE SUBSET

FORMAT IS CONVOLVED WITH A MULTICHANNEL LINEAR FILTER AND WRITTEN ONTO AN OUTPUT TAPE IN THE SUBSET FORMAT.

17. POINTFLT DISCRETE LAGUERRE FILTER

FORTRAN. THIS SUBROUTINE ACCEPTS ONE DATA INPUT AT A TIME AND PASSES THIS DATA THROUGH A SET OF RECURSIVE FILTER OPERATIONS WHICH CAN BE STATED EITHER AS A TIME OPERATION OR AS A FREQUENCY OPERATION.

18. RECFIL INTERPOLATION AND APPROXIMATION, FILTERING

FORTRAN. GIVEN AN INPUT TIME SERIES, A CENTER FREQUENCY, A BANDWIDTH, AND THE DATA SAMPLING RATE IN SECONDS PER POINT, THIS SUBROUTINE RETURNS THE FILTERED TIME SERIES, THE FILTER COEFFICIENTS, AND A COMPUTED PARAMETER OF THE FILTER POWER FUNCTION. THE PROGRAM WILL ALSO FILTER DATA IN SECTIONS.

19. RECFIL3 SINGLE PASS PHASE SHIFT RECURSIVE FILTER

FORTRAN. TO PERFORM ONE-PASS PHASE SHIFT RECURSIVE FILTERING OF SEISMIC DATA, GIVEN THE Q-VALUE, CENTER FREQUENCY, AND SAMPLING RATE.

20. RESREC PLOT RESPONSE OF RECURSIVE BAND FILTER

FORTRAN. COMPUTES AND PLOTS THE AMPLITUDE OF A RECURSIVE PHASELESS DIGITAL FILTER.

21. TWX SPATIAL INTERPOLATION

FORTRAN. TO COMPUTE A LEAST-MEAN-SQUARE-ERROR FILTER WHICH INTERPOLATES ONE CHANNEL OF AN ARRAY FROM CERTAIN OTHER CHANNELS IN THE ARRAY, APPLY THE FILTER TO CONSTRUCT AN INTERPOLATED ESTIMATE, CONSTRUCT THE ERROR TIME FUNCTION, AND DISPLAY THE POWER SPECTRUM OF THE ERROR.

D. DATA RETRIEVAL AND MANIPULATION

1. APCTRAI REARRANGE SUBSET DATA

FORTRAN. THIS PROGRAM OBTAINS ALL POSSIBLE COMBINATIONS, IN SETS OF TWO, OF SUBSET DATA CHANNELS AND FORMS AN OUTPUT TAPE CONTAINING A LABEL WITH EACH SET OF TWO RECORDS.

2. CENTRE CENTER A RECORD SUBROUTINE

FORTRAN. THIS SUBROUTINE CENTERS THE RECORD A(I) OF N POINTS INTO THE RECORD B(I) OF M POINTS AND PLACES ZEROES ON BOTH SIDES.

3. CNTUR4 CONTOURING

FORTRAN. CNTUR4 WRITES PRINTER PLOT OF THE CONTOURS OF A TWO-DIMENSIONAL ARRAY. THE CONTOURS ARE FORMED BY SHADING THE AREA BETWEEN LEVEL 2I AND LEVEL 2I + 1. THIS DISPLAY IS

SUPERIMPOSED UPON EITHER A GRID WORK OR A BORDER WITH TICK-MARKS. THE CONTOUR LEVELS MAY BE SPECIFIED INDIVIDUALLY, OR BY THE INCREMENT BETWEEN LEVELS. IN ADDITION, PROVISION HAS BEEN MADE TO ALLOW THE ORIENTATION OF THE ARRAY TO BE ALTERED BY EITHER EXCHANGING THE ROWS AND COLUMNS OR REVERSING EITHER THE ROWS OR THE COLUMNS.

4. COLLATE MERGES EPICENTER LISTS

FORTRAN. THIS PROGRAM TAKES TWO BINARY TAPES OR A PACKED BINARY TAPE AND EPICENTER CARDS AND SEARCHES FOR EVENTS WHICH ARE REPORTED ON BOTH. MATCHING IS DETERMINED BY COMPARISON WITH (1) A PREDETERMINED ORIGIN TIME DIFFERENCE WHICH INCLUDES A DEPTH-TIME CORRECTION AND (2) A PREDETERMINED DISTANCE DIFFERENCE WHICH INCLUDES A LATITUDE-LONGITUDE CORRECTION. LATITUDE, LONGITUDE, DEPTH, MAGNITUDE, AND ORIGIN TIME DIFFERENCES (RESIDUALS) ARE COMPUTED ONLY FOR MATCHING PARTS OF EVENTS AND ARE AVAILABLE AS OUTPUT.

5. DEPTHMAG RETRIEVAL AND COUNT OF EPICENTERS SUMMARIZED BY DEPTH AND MAGNITUDE

FORTRAN. THIS PROGRAM HAS THE ABILITY TO RETRIEVE DATA FROM ANY ONE OF FOUR DIFFERENTLY FORMATTED TAPES, THE ABILITY TO SAVE ALL CARD IMAGES RETRIEVED, ABILITY TO SPECIFY RETRIEVAL CRITERIA RELATIVE TO- A. RECORDING STATIONS
B. DATA SOURCE CODES
C. DISTANCE AND AZIMUTH
D. OTHER RELATED MISCELLANEOUS FEATURES

6. DETRND REMOVAL OF MEAN AND/OR LINEAR TREND

FORTRAN. THIS SUBROUTINE REMOVES THE MEAN ONLY OR BOTH THE MEAN AND LINEAR TREND OF A SERIES OF N POINTS, AND RETURNS THE DETRENDED SERIES.

7. EPLIST EPICENTER LISTING

FORTRAN. LIST THE INFORMATION CONTAINED IN PRE-PUNCHED USCGS EPICENTER CARDS FOR EARTHQUAKES SATISFYING PREDETERMINED VALUES FOR ANY DESIRED COMBINATION OF THE FOLLOWING VARIABLES- LATITUDE, LONGITUDE, DEPTH, MAGNITUDE, AZIMUTH, AND DISTANCE.

8. MERGSEIS MERGING OF 2 SEISMOGRAMS UNDER ONE LABEL

FORTRAN. THIS PROGRAM WILL TAKE ANY TWO SEISMOGRAMS FROM ONE TAPE AND MERGE THEM TOGETHER UNDER A NEW LABEL WITH 50 CHANNEL IDENTIFIERS.

9. NORMAL NORMALIZE SUBROUTINE

FORTRAN. COMPUTES AND RETURNS A NORMALIZED SERIES FROM A GIVEN SERIES OF N TERMS.

10. RANGE MAXIMUM AND MINIMUM VALUE SUBROUTINE

FORTRAN. FINDS AND RETURNS THE MAXIMUM AND MINIMUM VALUES OF A SERIES OF N TERMS.

11. SQUASH SCALING ROUTINE

FORTRAN. FINDS AND RETURNS THE MAXIMUM AND MINIMUM VALUES OF A SERIES OF N TERMS AND THEN SCALES THE SERIES WITH A GIVEN MAXIMUM ABSOLUTE VALUE.

12. TAPEACI EPICENTER DATA STANDARDIZATION

FORTRAN. VARIOUS EPICENTER CARDS FROM SEVERAL SOURCES ARE WRITTEN ONTO TAPE IN A STANDARD FORMAT IN BCD OR PACKED BINARY MODE. SEIS AND GEO REGION NUMBERS MAY BE ADDED INTO THE FORMAT. BINARY OR BCD TAPES MAY BE LISTED AT END OF AN UPDATE RUN OR MAY BE CONVERTED BACK TO STANDARD FORTRAN BCD.

13. TAPMERG2 TAPE MERGE

FORTRAN. TO MERGE TWO MAGNETIC TAPES, MADE UP OF EPICENTER CARD IMAGES ON MAGNETIC TAPE. THE RESULTING MERGED TAPE IS IN CHRONOLOGICAL SEQUENCE AND IN BCD MODE WITH END-OF-FILES BETWEEN MONTHS AND A DOUBLE-END-OF-FILE AT THE END OF THE YEAR.

14. TRAVELI COMPUTER P-ARRIVAL TIMES

FORTRAN. COMPUTES THE P-ARRIVAL TIMES FROM SEISMIC EVENTS, REPORTED ON PDE CARDS OF THE U.S. COAST AND GEODETIC SURVEY, TO SPECIFIED STATIONS AND LISTS THEM TOGETHER WITH ALL THE INFORMATION CONTAINED ON THE PDE CARDS.

E. INTERPOLATION AND APPROXIMATIONS

1. AUTODEQ CONTROLLED SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

FORTRAN. TO PROVIDE A CONVENIENT MEANS OF SOLVING A SET OF N SIMULTANEOUS FIRST ORDER DIFFERENTIAL EQUATIONS. THE BASIC INTEGRATOR IS A SELF STARTING VARIANT OF THE ADAMS METHOD INCORPORATING AUTOMATIC STEP SIZE CONTROL. USER PROVIDED STATEMENTS ARE EXECUTED AT SPECIFIED VALUES OF EITHER THE INDEPENDENT VARIABLE OR ANY CONTINUOUS FUNCTION OF THE DEPENDENT VARIABLES. AUTOMATIC CONTROL OF TRUNCATION OR DISCONTINUITY ERROR IS PROVIDED. THE DEPENDENT VARIABLES ARE INTERNALLY CARRIED IN PARTIAL DOUBLE PRECISION TO CONTROL ROUND OFF ERROR.

2. BES BESSEL FUNCTION

FORTRAN. THIS ROUTINE EVALUATES FOR A GIVEN X AND N, EITHER J(N) OR I(N) WHERE X IS A NORMALIZED FLOATING POINT NUMBER AND N IS A FIXED POINT INTEGER.

3. BFFGH SPHERICAL BESSEL FUNCTION

FORTRAN. THIS ROUTINE CALCULATES THE SPHERICAL BESSEL FUNCTION OF THE FIRST KIND AND OF THE SECOND KIND TOGETHER WITH THE FIRST AND SECOND DERIVATIVES FOR A GIVEN APGUMENT.

4. CERES ELEMENTARY FUNCTIONS

FORTRAN. THIS SUBROUTINE WAS WRITTEN TO PROVIDE THE SINE, COSINE, AND EXPONENTIAL FUNCTIONS PRECISELY ACCURATE TO 11 SIGNIFICANT DECIMAL FIGURES FOR ARGUMENTS NO GREATER THAN ROUGHLY 4(3.14).

5. CLABMU EIGENVALUES AND EIGENVECTORS

FORTRAN. GIVEN A COMPLEX SQUARE MATRIX, NOT NECESSARILY HERMITIAN, TO FIND ALL EIGENVALUES AND ONE EIGENVECTOR FOR EACH DISTINCT EIGENVALUE. THE ROUTINE USES THE LA BUDDE METHOD WITH DETERMINANT EVALUATION AND THE MUELLER METHOD.

6. CMPTPWR POLYNOMIALS, EVALUATION OF A SPECIAL FUNCTION

FORTRAN. THIS IS A FUNCTION SUBROUTINE WHICH EVALUATES THE EXPRESSION FOR THE POWER AT A GIVEN FREQUENCY FOR A BAND PASS FILTER.

7. EXTREM MULTI-DIMENSIONAL EXTREMUM SEEKER

FORTRAN. COMPUTES THE MAXIMA, MINIMA, OR SADDLE POINTS FOR A SINGLE FUNCTION OF UP TO 20 PARAMETERS.

8. GLQUAD GAUSSIAN LEGENDRE QUADRATURE

FORTRAN. THIS ROUTINE IS DESIGNED TO OFFER A SUBSTANTIAL IMPROVEMENT OVER THE USUAL USE OF SIMPSON S RULE TO APPROXIMATE DEFINITE INTEGRALS. THE GAUSSIAN LEGENDRE METHOD HAS THE HIGHEST ALGEBRAIC PRECISION FOR A GIVEN NUMBER, N, OF EVALUATIONS OF THE INTEGRAND.

9. GRSCH VECTOR ORTHONORMALIZATION

FORTRAN. THIS SUBROUTINE ORTHONORMALIZES THE INPUT SET OF VECTORS BY MEANS OF THE GRAM-SCHMIDT ORTHOGONALIZATION PROCEDURE. WHILE DOING THIS, IT CHECKS EACH NEW VECTOR COMPUTED TO SEE IF ITS NORM IS LESS THAN A SEPCIFIED QUANTITY. IF IT FINDS A NULL VECTOR, AND HENCE A LINEARLY DEPENDENT INPUT SET, IT RETURNS AN ERROR FLAG AND TERMINATES THE CALCULATION.

10. IDFUN INTERPOLATED FUNCTION AND ITS DERIVATIVE AND INTEGRAL

FORTRAN. GIVEN ANY SET OF ABCISSAS IN MONOTONICALLY INCREASING ORDER WITH CORRESPONDING ORDINATES- THE INTERPOLATED FUNCTIONS ARE OBTAINED AT THE DESIRED ABCISSAS- OR THE INTERPOLATED DERIVATIVES OF THE FUNCTION- OR THE INTEGRALS OF THE

FUNCTIONS- OR THE SUM OF THE INTEGRAL. THE INTEGRALS OF THE FUNCTIONS AND THE SUM OF THESE INTEGRALS ARE ALWAYS COMPUTED. THE CURVE IS PARABOLIC BETWEEN ADJACENT PAIRS OF POINTS AND THE DERIVATIVE AND FUNCTION IS MATCHED ON BOTH SIDES OF EACH POINT.

11. LAPINV — A SUBROUTINE FOR FINDING THE LAPLACE INVERSE OF A COMPLEX FUNCTION

FORTRAN. GIVEN A FUNCTION OF THE COMPLEX VARIABLE S, AND AN ARRAY OF THE INDEPENDENT VARIABLE TIME, TO GENERATE THE TIME FUNCTION FOR EACH OF THE TIME VALUES INDICATED.

12. LSUPOL — LEAST SQUARES POLYNOMIAL FITTING SUBROUTINE

FORTRAN. GIVEN X(I),X(1),X(2),....,X(M) AND F(I),F(2),...., F(M), WHERE F(I) IS THE OBSERVED DEPENDENT VARIABLE AND X(I) IS THE OBSERVED DEPENDENT VARIABLE AND X(I) IS THE OBSERVED INDEPENDENT VARIABLE, THE POLYNOMIAL Y = B(1) + B(2) *X + ... +B(+1)*X**K IF FITTED FOR ALL DEGREES OF K, FROM K=1 TO K = K(MAX) WITH CERTAIN OPTIONS.

13. RFH — PROGRAMMED ARITHMETIC, REAL

FORTRAN. THIS SUBROUTINE EMPLOYS THE REGULA FALSI METHOD TO FIND THE VALUE OF THE INDEPENDENT VARIABLE FOR A PARTICULAR VALUE OF THE DEPENDENT VARIABLE (OR FUNCTION).

14. RKAM — NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

FORTRAN. TO COMPUTE THE NUMERICAL SOLUTIONS OF A SYSTEM OF N, (N.LE.100), SIMULTANEOUS FIRST -ORDER ORDINARY DIFFERENTIAL EQUATIONS WITH GIVEN INITIAL CONDITIONS OVER A GIVEN INTERVAL USING PARTIAL DOUBLE-PRECISION ARITHMETIC. THE METHOD OF SOLUTION MAY BE EITHER, (1) RUNGE-KUTTA, (2) ADAMS-MOULTON, WITHOUT ERROR CHECKING, OR (3) ADAMS-MOULTON WITH ERROR CHECKING. THE LATTER TWO USE RUNGE-KUTTA STARTERS.

15. RKAMSUB — NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

FORTRAN. TO COMPUTE THE NUMERICAL SOLUTION OF A SYSTEM OF N, (N .LE.100), SIMULTANEOUS FIRST-ORDER ORDINARY DIFFERENTIALS WITH GIVEN INITIAL CONDITIONS, USING PARTIAL DOUBLE-PRECISION ARITHMETIC.

16. SPEEDUR — VECTORS AND SIMULTANEOUS LINEAR EQUATIONS

FORTRAN. TO DETERMINE AN N X 1 VECTOR X WHICH MINIMIZES THE MAXIMUM ABSOLUTE VALUE OF ALL THE COMPONENTS IN THE VECTOR B - AX. HERE B IS AN M X 1 VECTOR AND A IS AN M X N MATRIX OF RANK N WHERE M.LE.N + 1. AN X WHICH DOES THIS IS CALLED A MIN-MAX OR CHEBYSHEV SOLUTION TO THE OVER-DETERMINED SYSTEM AX = B.

17. TRAPZ TRAPEZOIDAL RULE INTEGRATION

FORTRAN. EVALUATES THE INTEGRAL OF F(X)DX FOR A SUCCESSION OF F(X)S BY THE TRAPEZOIDAL RULE.

18. ZOEPPRIT ZOEPPRITZ S EQUATIONS

FORTRAN. TO CALCULATE COEFFICIENTS OF REFLECTION AND REFRACTION FOR GIVEN BOUNDARY CONDITIONS USING ZOEPPRITZ S EQUATIONS.

F. GENERAL SEISMIC PROGRAMS

1. ARESPONS OFF-BEAMED ARRAY RESPONSE PROGRAM

FORTRAN. THIS PROGRAM COMPUTES AND PLOTS THE DB LOSS FOR SIGNALS COMING IN FROM ANGLES DIFFERENT FROM THE BEAMSTEER AZIMUTH. ELABORATE PRINTOUTS AND PLOTS ARE GENERATED IN ORDER TO MAKE THE OUTPUT SELF-EXPLANATORY.

2. CALIB MAGNIFICATION CALCULATION USING DIGITIZED SINE WAVE CALIBRATIONS

FORTRAN. COMPUTES THE AVERAGE PEAK-TO-PEAK AMPLITUDE. THE MAGNIFICATION, AND NORMALIZING FACTORS OF A DIGITIZED SINE WAVE CALIBRATION. THE Y FACTORS FOR EACH TRACE MAY BE INPUT OR THEY MAY BE CALCULATED, GIVEN SPECIFIED INPUT PARAMETERS.

3. CON2A CONVOLUTION

FORTRAN. TO ADD TWO SPIKE SEISMOGRAMS TOGETHER, CONVOLVE THEM WITH A THIRD SEISMOGRAM AND CONVOLVE THE RESULTS WITH A WAVELET TO PRODUCE A SIMULATED SEISMOGRAM,

4. DEGOSTE GHOST REFLECTIONS

FORTRAN. TO REMOVE GHOST REFLECTIONS WHEN A SURFACE AND DEEP WELL TRACE AT THE SAME GAIN IS AVAILABLE.

5. DEGSEIS VERTICAL ARRAY PROCESSOR PACKAGE II

FORTRAN. TO DEGHOST VERTICAL ARRAY SEISMOGRAMS GIVEN AN ECHO-TIME AND REFLECTION COEFFICIENT FOR EACH SEISMOGRAM. IN ADDITION, A SUM TRACE OF THE DEEPWELL TRACES, AND A SUM TRACE OF THE ALIGNED-DEGHOSTED-DEEP-WELL TRACES ARE COMPUTED. ALSO THE COMPONENT WHICH IS JOINTLY CORRELATED ON ALL ALIGNED-DEGHOSTED-DEEP-WELL TRACES IS COMPUTED. FURTHERMORE THIS PROGRAM PLOTS ALL DEEPWELL AND DEGHOSTED DEEPWELL TRACES, THE PAIR OF SUM TRACES, AND THE CORRELATION TRACE.

6. DISCRETE EVALUATION OF KAUTE EXPANSION COEFFICIENTS

FORTRAN. EXPANDS EITHER A SEISMIC SIGNAL OR A SPECIFIED FUNCTION IN TERMS OF A SET OF ORTHONORMALIZED EXPONENTIAL FUNCTIONS. PARAMETERS GIVEN BY THE USER DEFINE THE ORTHONORMAL

FUNCTIONS. THE SPECTRUM OF THE EXPANSION IS AVAILABLE AS AN OPTION.

7. DISPLAY DISPLAY AND ANALYSIS OF AVOMALIES

FORTRAN. TO TAKE THE OUTPUT FROM THE ANOMALY PROGRAM AND COMPUTE THE AVERAGE, STANDARD DEVIATION, AND NUMBER OF OCCURRENCES OF A SELECTED ANOMALY FOR SELECTED SUBARRAYS OR SENSORS, DISTANCES, AND AZIMUTHS.

8. DISTA DISTANCE, AZIMUTH, AND TRAVEL TIME

FORTRAN. COMPUTES THE DISTANCE IN DEGREES AND KILOMETERS, THE AZIMUTH, BACK AZIMUTH, THE TRAVEL TIME OR ARRIVAL TIME, AND THE ROTATIONS PARAMETERS FROM A SPECIFIED SEISMIC EVENT TO A GIVEN STATION.

9. DSST DUMMY SEISMOGRAM SUBSET TAPE

FORTRAN. CREATES A DUMMY SUBSET TAPE, REMOVES MEAN OF EACH CHANNEL AND NORMALIZES ENERGY, THEN SMOOTHS EACH WITH A FILTER.

10. DESPIKE DESPIKE SEISMOGRAMS

FORTRAN. TO REMOVE SPIKES FROM SEISMOGRAMS BY SIMPLY INSERTING A COSINE FUNCTION IN A SPECIFIED INTERVAL.

11. ELIPT ELLIPTICITY

FORTRAN. TO COMPUTE THE RATIO OF THE RADIAL AND VERTICAL COMPONENTS OF RAYLEIGH MOTION AS A FUNCTION OF PERIOD.

12. GRUVEL GROUP VELOCITY FROM PHASE VELOCITY DISPERSION

FORTRAN. THIS PROGRAM TAKES THE PHASE VELOCITY VERSUS PERIOD OR FREQUENCY POINTS AND USES THE POLYNOMIAL AND ITS DERIVATIVES TO OBTAIN THE GROUP VELOCITY AS A FUNCTION OF PERIOD OR FREQUENCY.

13. HARKRIDR RAYLEIGH WAVE DISPERSION

FORTRAN. TO COMPUTE RAYLEIGH WAVE GROUP VELOCITY, PHASE VELOCITY, AND INVERSION COEFFICIENTS AS A FUNCTION OF FREQUENCY.

14. HEFALUMP MEASURED NOISE ISOTROPIC PROCESSOR

FORTRAN. THIS PROGRAM COMPUTES AND/OR APPLIES A MULTICHANNEL ISOTROPIC PROCESSOR TO SEISMIC ARRAY DATA. AN ACTUAL NOISE MODEL IS USED COMPUTED FROM THE SPECTRA OF A SPECIFIED DATA SAMPLE. EITHER A POINT OR A DISC SIGNAL MODEL CAN BE COMPUTED. THE PROGRAM THEN SOLVES THE MULTICHANNEL WIENER-HOPF EQUATION IN THE FREQUENCY DOMAIN TO GET THE OPTIMUM FILTER WHICH REJECTS THE NOISE AND PASSES THE SIGNAL. THE FILTER IS WRITTEN ON A SAVE TAPE FOR FUTURE USE. AN OPTION EXISTS TO FILTER A GIVEN PIECE OF DATA AND PLOT THE FILTERED TRACE AND THE DIRECT SUM. PERSON PLOTS ARE ALSO GENERATED AND PLOTTED WHICH, IN CONJECTION WITH

THE OUTPUT PLOTS, ALLOW THE USER TO CALCULATE SIGNAL TO NOISE RATIOS.

15. ISOFIL THEORETICAL ISOTROPIC PROCESSOR

FORTRAN. THIS PROGRAM COMPUTES AND/OR APPLIES A MULTICHANNEL ISOTROPIC PROCESSOR TO SEISMIC ARRAY DATA. AN ANNULAR RING NOISE MODEL AND EITHER A POINT OR A DISC SIGNAL MODEL CAN BE SPECIFIED. THE PROGRAM THEN SOLVES THE MULTICHANNEL WIENER-HOPF EQUATION IN THE FREQUENCY DOMAIN TO GET THE OPTIMUM FILTER WHICH REJECTS THE NOISE AND PASSES THE SIGNAL. THE FILTER IS WRITTEN ON A SAVE TAPE FOR FUTURE USE. AN OPTION EXISTS TO FILTER A GIVEN PIECE OF DATA AND PLOT THE FILTERED TRACE AND THE DIRECT SUM. PERSON PLOTS ARE ALSO GENERATED AND PLOTTED WHICH, IN CONJUNCTION WITH THE OUTPUT PLOTS, ALLOW THE USER TO CALCULATE SIGNAL TO NOISE RATIOS.

16. LAGTIME SIGNAL AND NOISE ADDITION

FORTRAN. THIS PROGRAM COMBINES A SIGNAL AND A NOISE ONTO THE SAME DATA CHANNEL AT VARYING SIGNAL-TO-NOISE RATIOS. A TAPE OF THE NEW COMBINATION OF DATA IS WRITTEN AND A PLOT TAPE IS FORMED.

17. LOCATE DETERMINATION OF LATITUDE, LONGITUDE, DEPTH, AND ORIGIN TIME OF A SEISMIC SOURCE

FORTRAN. CALCULATES, BY AN INTERACTIVE LEAST-SQUARES PROCESS, THE LATITUDE, LONGITUDE, DEPTH, AND ORIGIN TIME OF A SEISMIC SOURCE, AND DETERMINES THE CONFIDENCE INTERVALS AND JOINT CONFIDENCE REGION FOR THE SOURCE COORDINATES. COMPRESSIONAL WAVE ARRIVAL TIMES FROM FIVE OR MORE STATIONS ARE USED.

18. MAKARAY ARRAY SIMULATION

FORTRAN. PRODUCES A SET OF OUTPUT TRACES CORRESPONDING TO ANY SET OF ELEMENT POSITIONS DESIRED. A NOISE BACKGROUND IS SIMULATED BY SELECTING TEN TRACES FROM A SET OF TWENTY SAMPLE TRACES, AND ASSIGNING TO EACH TRACE AN ARBITRARY VELOCITY, AZIMUTH AND RELATIVE AMPLITUDE. A SIGNAL IS SELECTED FROM A SET, ITS VELOCITY AND AZIMUTH ARE CHOSEN AND A SIGNAL-TO-NOISE RATIO IS ASSIGNED.

19. MASVOSE MEAN AND SAMPLE VARIANCE OF SPECTRAL ESTIMATES

FORTRAN. TO COMPUTE THE MEAN AND SAMPLE VARIANCE OF SPECTRAL ESTIMATES.

20. MOD PV-7 SURFACE WAVE DISPERSION AND AMPLITUDE

FORTRAN. THIS PROGRAM COMPUTES FOR ALL MODES OF LOVE AND RAYLEIGH WAVES ON AN ELASTIC HALFSPACE OF PLANE-PARALLEL, HOMOGENEOUS, ISOTROPIC LAYERS, THE FOLLOWING- PHASE VELOCITY, GROUP VELOCITY, AND SURFACE ORBIT AS FUNCTIONS OF PERIOD OR FREQUENCY- AMPLITUDE, THE PRODUCT OF VERTICAL WAVE NUMBER TIMES LAYER THICKNESS, AND POTENTIALS AS FUNCTIONS OF DEPTH- AVERAGE

KINETIC, POTENTIAL, AND TOTAL ENERGY DENSITIES, AND AVERAGE HORIZONTAL ENERGY FLUX, CORRESPONDING TO EACH LAYER- AND A SUMMATION OF THE ENERGY QUANTITIES FROM THE FREE SURFACE. PROVISION IS MADE FOR PRINTER PLOTS OF PHASE AND GROUP VELOCITY. PROVISION IS ALSO MADE FOR PARTIAL DECOUPLING WHERE AMPLITUDE IS LARGE IN CERTAIN CHANNELS AT DEPTH, RELATIVE TO THE SURFACE AMPLITUDE.

21. NETWORK2 EVENT PROCESSOR

FORTRAN. GIVEN SETS OF SEISMIC STATIONS AND EVENTS, THIS PROGRAM PROCESSES INFORMATION, RELATIVE TO VARIOUS SPECIFIED EVENT MAGNITUDES AND A THRESHOLD PROBABILITY. THIS PROGRAM COMPUTES THE NETWORK PROBABILITY AND STATION CAPABILITY OF DETECTION OR IDENTIFICATION OF SEISMIC EVENTS. IT ALSO COMPUTES THE THRESHOLD MAGNITUDE FOR ALL STATIONS AND UP TO 17 EVENTS AND SUBSETS OF EVENTS. IN ADDITION, IT COMPUTES THE NUMBER OF EVENTS OCCURRING ABOVE A GIVEN MAGNITUDE AND HOW MANY OF THOSE EVENTS WILL BE IDENTIFIED OR GO UNDETECTED FOR SPECIFIED SUBSETS OF EVENTS AND STATIONS.

22. NOSPIKE SPIKE REMOVER

FORTRAN. TO REMOVE SPIKES AND CLIPS FROM SEISMOGRAMS.

23. PSDALPH PSEUDO DEPTH, ALPHA, AND BETA

FORTRAN. TO COMPUTE THE PSEUDO-LAYER THICKNESSES, PSEUDO-COMPRESSIONAL AND -SHEAR VELOCITIES FOR A GIVEN EARTH STRUCTURE. ANY LAYER WITHIN THE STRUCTURE MAY BE DIVIDED INTO N SUB-LAYERS. THE CORRESPONDING ALPHAS, BETAS, THICKNESSES, DEPTHS, AND DENSITIES ARE DEFINED FOR EACH SUB-LAYER USING A LINEAR GRADIENT ACROSS THE ORIGINIAL LAYER.

24. RESPOND ARRAY AZIMUTH RESPONSE

FORTRAN. TO COMPUTE THE RESPONSE OF AN ARRAY TO WAVE NUMBERS ALONG ONE AZIMUTH.

25. RESPONSE ARRAY RESPONSE

FORTRAN. TO CALCULATE AND PLOT IN K-SPACE THE RESPONSE OF AN ARRAY OF SEISMOMETERS WITH RESPECT TO THE RESPONSE OF THE SAME ARRAY TO WAVES WITH INFINITE PHASE VELOCITY (EX. NUMBER OF DB DOWN FROM ZERO).

26. RMSONLY COMPUTATION OF RMS

FORTRAN. TO READ UP TO 9 SEISMOGRAMS FROM A MAGNETIC TAPE, IN SUBSET TAPE FORMAT, DETREND, FILTER (OPTIONAL), COMPUTE RMS ON A PARTICULAR DESIRED REGION, AND THE MEAN OF THE RMS.

27. ROTATE SEISMOGRAM ROTATION PROGRAM

FORTRAN. THIS PROGRAM TAKES A SUBSET OF SEISMOGRAMS WITH THE Z, R, T, AND POSSIBLY TIME CHANNELS AND MAKES ONE OF THREE

POSSIBLE ROTATIONS ON THE PREDETERMINED SEISMOGRAMS ON THE SUBSET TAPE. THE THREE POSSIBLE ROTATIONS ARE-

1. (Z) AXIS ROTATION GIVING AN OUTPUT Z, RZ, AND TZ
2. (Z-T PRIME) AXIS ROTATION GIVING AS OUTPUT ZT, RZT, AND TZ
3. (Z-R PRIME) AXIS ROTATION GIVING AS OUTPUT ZR, RZ, AND TZR

OUTPUT WILL INCLUDE A NEW SUBSET TAPE WITH THE Z, R, AND T CHANNELS (OR FOUR, IF THE TIME CHANNEL IS GIVEN), AND A PRINTOUT OF SUBSET INFORMATION AND PLOT SCALE FACTORS.

28. SDEGSET VERTICAL ARRAY PROCESSOR PACKAGE II, ADJUSTED

FORTRAN. TO REMOVE GHOST REFLECTION ON VERTICAL ARRAY SEISMOGRAMS ALIGNED FOR FIRST P-MOTION GIVEN ONLY THE ECHO-TIMES AND REFLECTION COEFFICIENTS. IN ADDITION SUM TRACES OF BOTH THE ALIGNED DEEPWELL AND ALIGNED-DEGHOSTED-DEEPWELL TRACES ARE COMPUTED. ALSO THE COMPONENT WHICH IS JOINTLY CORRELATED ON ALL DEGHOSTED SEISMOGRAMS IS COMPUTED. FURTHERMORE PLOTS ARE OBTAINED OF ALL DEEPWELL AND DEGHOSTED DEEPWELL TRACES, THE SURFACE TRACE, THE TWO ABOVE SUM TRACES, AND THE CORRELATION TRACE.

29. SEE SPECIFIC DRIVING PROGRAM FOR FRAMIS

FORTRAN. THIS PROGRAM WAS WRITTEN FOR THE SPECIFIC PURPOSE OF DRIVING FRAMIS. FRAMIS EVALUATES THE AMPLITUDE AND PHASE OF A TRANSFER FUNCTION GIVEN THE PARAMETERS OF THAT FUNCTION. THE INPUT TO SEE ARE THE OPERATING PARAMETERS FOR FRAMIS AND THE PARAMETERS OF THE LAPLACE TRANSFORM. THE OUTPUT OF SEE IS A LISTING OF AMPLITUDE (RAW OR NORMALIZED TO A REQUESTED FREQUENCY) AND PHASE AS A FUNCTION OF FREQUENCY. CASES MAY BE BATCHED.

30. SEGMENTM SEGMENT MULTIPLEX TWO

FORTRAN. LONG SEISMOGRAMS ARE BROKEN UP INTO MULTIPLEXED SEGMENTS OF DESIRED LENGTH.

31. SIMDEEP VERTICAL ARRAY SEISMOGRAM SIMULATION

FORTRAN. TO SIMULATE THE DEEPWELL TRACE OR TRACES FROM MEASUREMENTS OF A SURFACE OR NEAR-SURFACE SEISMOGRAM, GIVEN THE ECHO-TIMES BETWEEN THE DEEPWELL AND THE SURFACE AND GIVEN THE REFLECTION COEFFICIENT. THE SUM TRACE OF THE DEEPWELL SEISMOGRAMS AND THE SUM TRACE OF THE SIMULATED DEEPWELL SEISMOGRAMS ARE COMPUTED. PLOTS ARE OBTAINED OF THE DEEPWELL SEIGMOGRAMS, SIMULATED DEEPWELL SEISMOGRAMS, THE SURFACE TRACE, AND THE TWO ABOVE SUM TRACES.

32. SIMGO SIMULATED GHOST REFLECTION

FORTRAN. TO SIMULATE NORMAL DEEPWELL TRACES.

33. SIMVARRY VERTICAL ARRAY SIMULATION

FORTRAN. TO SIMULATE AN N COMPONENT VERTICAL ARRAY ACCORDING TO THE FOLLOWING CRITERIA-

1. SURFACE TRACE CONTAINS A SIGNAL COMPOSED OF A PSEUDO

P-PULSE AND WAVELET FORMED BY SURFACE REVERBERATIONS AT SOURCE.

2. EACH DEEPWELL TRACE HAS SAME SIGNAL AS SURFACE WITH THE ADDITION OF SURFACE GHOST AT THE VERTICAL ARRAY.
3. EACH DEEPWELL SIGNAL IS SHIFTED BY THE DESIRED TIME DELAY IN ORDER TO SIMULATE WHAT WOULD BE RECORDED IN NATURE.
4. NO OTHER PULSES ARE CONSIDERED.
5. NOISE IS 90 PER CENT COHERENT BETWEEN SUCCESSIVE ARRAY ELEMENTS.

34. SPECAVE SPECTRAL MATRIX AVERAGING PROGRAM

FORTRAN. THIS PROGRAM COMPUTES AND AVERAGES SPECTRAL MATRICES FOR MULTICHANNEL SEISMIC ARRAY DATA. THE OUTPUT OF THIS PROGRAM IS A TAPE IN THE SAME FORMAT AS THE PROGRAM -HEFALUMP- SAVE TAPE. USING THAT TAPE AS INPUT TO THE -HEFALUMP- PROGRAM ALLOWS THE USER TO COMPUTE MULTICHANNEL FILTERS FROM AN ENSEMBLE OF NOISE SPECTRA. THIS PROGRAM IS ALSO DESIGNED TO ADD TO OR UPDATE AN ENSEMBLE SPECTRAL MATRIX ON TAPE FROM A PREVIOUS RUN.

35. SPECMAT THEORETICAL POWER SPECTRAL DENSITY MATRIX

FORTRAN. TO COMPUTE THE THEORETICAL POWER SPECTRAL DENSITY MATRIX FOR THE GAUSSIAN MARKOV MODEL. ALL SPECTRA ARE NORMALIZED TO THE ABSOLUTE MAXIMUM VALUE OF THE SPECTRAL SET. IN ADDITION EACH SPECTRAL COMPONENT P(RS,F) OF THE MATRIX IS SCALED BY THE FACTOR (LOGF(1.+IP(RS,F)(1)*100.))/1P(RS,F)(1) SO THAT AT HIGHER FREQUENCIES THE SPECTRAL VALUES ARE OBSERVABLE ON THE MATRIX PLOT. THE POWER SPECTRAL DENSITY MATRIX CONSISTS OF THE REAL PART BELOW, AND THE AUTO-SPECTRA ALONG THE DIAGONAL.

36. SPECMTRX THEORETICAL POWER SPECTRAL DENSITY, COHERENCY AND PHASE MATRICES

FORTRAN. TO COMPUTE THEORETICAL POWER SPECTRAL DENSITIES, COHERENCIES, AND PHASES FOR THE GAUSSIAN MARKOV CHAIN. TWO MATRICES ARE GENERATED, HAVING ALL POWER SPECTRA NORMALIZED TO THE MAXIMUM VALUE OF THE SPECTRAL SET, COHERENCY TO A PLAUSIBLE VALUE OF 1, AND PHASE TO AN APPROPRIATE VALUE OF PI. IN ADDITION THE POWER SPECTRA P(RS,F) IS SCALED ACCORDING TO THE FACTOR (LOGF (1. +1P(RS,F)1*100.)/1P(RS,F)1) FOR OBSERVABILITY AT HIGHER FREQUENCIES.

37. SPECSUB2 FILTER AND SUBSET PROGRAM

FORTRAN. TO DETREND, FILTER (FOUR POLE BUTTERWORTH), AND SUBSET DATA FROM EITHER A LIBRARY OR SUBSET TAPE AND PLOT THIS DATA. OPTIONS ARE INCLUDED TO DEMAGNIFY THE DATA, GENERATE PLOTS OF THE RESULTS, AND PROCESS MORE THAN ONE SEISMOGRAM.

38. VERPROC VERTICAL ARRAY PROCESSING

FORTRAN. TO PROCESS VERTICAL ARRAY DATA IN THE FOLLOWING MANNER-
1- DETREND, TAPER, AND CORRECT FOR INSTRUMENT GAIN.
2-COMPUTE RMS NOISE, SIGNAL PEAK TO PEAK EXCURSION, AND SIN RATIO FOR ALL VA ELEMENTS.

3- FORM THE DEGHOSTING OPERATOR G(J) OF W FOR EACH VA TRACE WITH/WITHOUT BRENNER WEIGHING.

4- COMPUTE THE FOURIER SERIES EXPANSION GT(J) OF LAMDA OF EACH G(J) OF W.

5- CONVOLVE GT(J) OF LAMDA WITH ITS CORRESPONDING DEEPWELL TRACE TO PRODUCE A DEGHOSTED CONVOLUTION RECORD.

39. XMNG SPECTRAL MATRIX ESTIMATES

FORTRAN. THIS IS A PACKAGE OF THREE FORTRAN 63 SUBROUTINES FOR COMPUTING AN ESTIMATE OF THE SPECTRAL MATRIX FOR N CHANNELS OF TAPED DATA. THE NAMES OF THE THREE ROUTINES IN THE PACKAGE ARE- XMNG, COOLER, AND SMOOTH. IN ADDITION TO THESE, THREE MORE SUBROUTINES ARE ASSUMED TO BE ON THE SYSTEM TAPE, THEY ARE- COOL, DISC63, AND ERASE.

40. YFACT Y FACTOR

FORTRAN. TO COMPUTE Y CALIBRATION FACTORS FOR DIGITIZED SEISMOGRAMS.

II. Digitized Seismic Data

The SDL library of digital data includes short and long period seismograms from over 100 U.S. nuclear explosions and 1000 earthquakes recorded at various LRSM sites and the VELA observatories. A complete list of digitized data is available upon request, but users are encouraged to visit the SDL to ascertain that the data is applicable to their project.

Digitized data can be punched on cards or written on tape in a 7 track IBM compatible format.

III. USC&GS Epicenters

Information contained in the USC&GS PDE cards has been punched on cards and written on magnetic tape. A copy of the tape containing epicenter information from 1960 to date is available upon request. FORTRAN programs to retrieve data from the tapes include:

- DEPTHMAG - retrieves epicenter data which meet various criteria such as location, depth, magnitude distance, azimuth, geographic region, and recording stations.
- ARRIVAL - arrival times of 23 seismic phases at any given station for any set of epicenters.
- TRAVEL T - computes arrival time, distance, and azimuth for a given station.

IV. Earthquake Bulletin Data

Earthquake bulletin data from the LRSM teams (February 1962 to date) and the VELA observatories (February 1963 to date) has been stored on magnetic tape. The data includes the PDE cards plus all phase information for those stations which recorded the earthquake. Recorded phase arrivals not associated with an epicenter are also on the tape.

V. Shot Report Data

Shot report data from 82 U.S. nuclear explosions have been punched on cards. These reports contain phase arrivals recorded at the LRSM stations and VELA observatories. The information recorded includes:

- Shot Name
- Location
- Magnitude
- Origin Time
- Recording Station
- Phase
- Arrival Time
- Amplitude
- Period